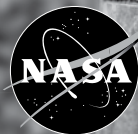


National Aeronautics and  
Space Administration



# EXCAVATION MANUAL

NASA Glenn Research Center



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# REFERENCES

- The Glenn Safety Manual, Chapter 35-Digging, Trenching and Excavating
- Digging, Trenching, and Excavating Permit, NASA Form C-927
- NASA Survey and Utility Location Service
- NASA Contract Drawings and Specifications that govern the execution of the work
- NASA Underground Record Drawings (URDs)
- Ohio Revised Code (ORC) 153.64
- Ohio Revised Code (ORC) 3781.25-3781.32
- OSHA Standard 29 CFR 1926 Subpart P
- Ohio Utilities Protection Service

# ACRONYMS and ABBREVIATIONS

<b>APWA</b>	American Public Works Association
<b>COR</b>	Contracting Officer's Representative
<b>CM</b>	Construction Manager
<b>FE</b>	Energy and Environmental Management Office
<b>FOS</b>	Facility Operations Specialist
<b>GRC</b>	Glenn Research Center
<b>ORC</b>	Ohio Revised Code
<b>POC</b>	Point of Contact
<b>SHeD</b>	Safety and Health Division
<b>SSC</b>	Support Services Contractor
<b>URD</b>	Underground Record Drawing
<b>OUPS</b>	Ohio Utilities Protection Service



# FOREWORD

## From the Glenn Research Center, Glenn Safety Manual Chapter 35—Digging, Trenching, and Excavating

### “PURPOSE:

...To ensure the safety of workers or visitors in or around excavation activities or ground penetration activities performed at the Glenn Research Center...

...Excavation and trenching are among the most hazardous construction operations...There are approximately **24 underground utility systems at GRC**. This has caused potentially serious situations during construction and maintenance activities...

...It is GRC's policy to evaluate all excavation and ground penetration activities to minimize the potential of cave-ins, environmental contamination, underground utility damage, or contact with subsurface encumbrances...”

**NO EXCAVATION OF ANY DEPTH SHALL  
COMMENCE WITHOUT A COMPLETE PERMIT**



**EMERGENCY DISPATCH**  
**911 (NASA Internal Phone)**  
**216-433-8888 (Lewis Field)**  
**419-621-3222 (Plum Brook)**



# INTRODUCTION

This booklet contains information pertinent to safety and procedural requirements for performing any excavation activity at any facility operated or maintained by the **NASA Glenn Research Center**, including both Lewis Field and Plum Brook Station. All NASA Construction and Safety Personnel are required to stringently enforce all regulations and requirements. This is intended as a **summary** of basic requirements and is **not a substitute** for full understanding by the contractor of the requirements set forth in **OSHA Standard 29 CFR 1926.651**.



## NOTE

This booklet does not contain the full text of the Ohio Revised Code  
**ORC 153.64** or **ORC 3781.25-3781.32**

To find the full text search online text shown above in **blue**.

This booklet is not a legal reference.

Consult with an attorney for advice on interpreting the law.

**THIS BOOKLET IS SUBJECT TO CHANGE WITHOUT NOTICE**

# EXCAVATION at GRC

## OHIO REVISED CODE 3781.250

“Excavation means the use of hand tools powered equipment or explosives to move earth, rock or other materials in order to penetrate or bore or drill into the earth, or to demolish any structure whether or not it is intended that the demolition will disturb the earth..”

### **NO EXCAVATION OF ANY DEPTH SHALL COMMENCE WITHOUT A COMPLETE PERMIT**

Including, but not limited to:

- Demolition of buildings, pavement, and structures of any kind, even if you do not expect to disturb the earth during demolition.
- Razing, wrecking, and tree stump removal
- Planting of trees, bushes, and landscaping
- Borings for soil samples taken for any purpose
- Auguring, drilling, potholing, and tunneling
- Grading, ditching, digging, and scraping
- Setting or driving fence poles or sign posts
- Pipe, cable, or duct bank trench excavation
- Pipe or cable installation by trenchless method
- Hydraulic or other nondestructive excavation type



# GRC EXCAVATION PERMIT

**A FULLY EXECUTED NASA FORM C927,  
“DIGGING, TRENCHING, AND EXCAVATING PERMIT”  
IS REQUIRED PRIOR TO PERFORMING  
ANY EXCAVATION ACTIVITY AT THE  
NASA GLENN RESEARCH CENTER!**

## EXCAVATION PERMIT WORK AREA

**WORK AREAS** are limited to a 400 linear foot section or to approximately 1 acre. Areas are to be divided and organized by street, parking lot, or building location. The contractor shall submit desired area for consideration. It will be at the discretion of the Civil Systems Manager to approve permit limits.

The permit shall only be applicable to the approved defined **WORK AREA**. The permit will be **CLOSED** after 3 months or after all excavation activities within the permit-defined **WORK AREA** are complete, whichever comes first. Contractors operating multiple crews simultaneously are required to have individual permits for each crew. Contractor shall request renewal of permit every two weeks or when re-entering an area for refreshing the markings.

The contractor will be responsible to attach a construction drawing to each **PART A** permit with the **WORK AREA** defined by dimensions. A description of work activities shall be included.

**THE PERMIT SHALL ONLY BE APPLICABLE  
FOR THE APPROVED DEFINED AREA**



## **PERMIT PART A (PDF SIGN OFF)**

### **Step 1 - NASA/SSC Initiator**

- For typical excavation activities the NASA Construction Manager will facilitate the permit process upon initiation by the contractor.

### **Step 2 - Soil Characteristics**

- The GRC Soil Coordinator will ensure that soil handling requirements have been sufficiently determined.
- Notify NASA Surveyor that pre-excavation identification/ marking activities can proceed.
- Attach approved Soil Determination Checklist, NASA C133.

### **Step 3 - NASA Surveyor**

- Identify and mark known underground utilities based upon limits of excavation provided by the contractor.
- The NASA Surveyor is to locate existing utilities and provide to the contractor an underground record drawing of the permit area.

### **Step 4 - SHeD Notification**

- SHeD shall be contacted prior to field activities to ensure that a preliminary confined space determination is made.

### **Step 5 – Excavation and Infrastructure Approval**

- Utility System Manager reviews installation.
- Civil Systems Manager reviews for safety, process, and procedure.





## PERMIT PART B

Utility verification and remarking (if necessary) is required every 2 weeks if working in the same area or as contractors change permit areas. Additional “freshening” of utility markings will be provided as requested by the contractor or as site conditions change as directed by CM/Inspector. The front page will be signatures for utility revalidation, and the back will be the potholing log.

The contractor is required to verify (pothole) all utilities as identified on Underground Record Drawing (URD) prior to completing infrastructure excavation (see page 24 for potholing definition). Waivers to this process can be granted by the Civil Systems Manager. The construction contractor shall contact CM/Inspector to initiate the utility verification process. The Government Surveyor will verify the exposed utilities match what is identified on the URDs and as directed in the drawings and/or specification. If there is a question on a utility location or identification the CM/Inspector shall contact the Government Civil Engineer for further direction prior to proceeding.

## PERMIT PART C

**DAILY FIELD TAG UP MEETINGS** will be held between the CM/Inspector and contractor to discuss areas of planned work for the day, hazards and utilities in those areas, emergency contact information, utility markings in field. The CM/Inspector shall not sign off on any daily permit unless the appropriate design drawings, underground record drawing, and field survey markings are on-site and completed. The contractor may only proceed with the work scope discussed for that specific day.

- The Daily Meeting may be held on the morning of or after noon prior to the specific day, depending upon NASA and Contractor schedules.
- If the contractor is found working in an unapproved area, the Government shall immediately stop work with no financial repercussion to the Government. The CM/Inspector/FOS is to contact COR for direction.

# COMPETENT PERSON

## EXCAVATOR PERSONNEL REQUIREMENTS

- All individuals involved in digging, trenching, excavating and ground penetration activities shall be trained in the hazards associated with these activities and in the emergency action to take if an underground utility or structure is hit or broken during these activities.
- Verification of these requirements is done by SHeD and the Facilities Division Project Management Branch by review of documentation submitted by the contractor as required with contract documents.

## EXCAVATOR SUPERVISION REQUIREMENTS

Contractor must provide the following:

- **Excavation Competent Person**  
(Permit Part A)  
or
- **Excavation and Utility Competent Person**  
(Permit Part B)



to oversee each permitted excavation depending upon the type of work being performed. This person shall be at the physical excavation site 100% of the time comparing construction documents to the URDs, auditing the excavation process, evaluating utility markings, evaluating typical symbols versus details and ensuring the permit process is followed.

**All competent persons must take GRC Excavation 101 SATERN Course GRC-012-15 every three years or each contract period, whatever is most stringent.**

The **EXCAVATION COMPETENT PERSON** assigned to supervise **PERMIT PART A** activities shall:

1. Have a working knowledge of trenching, excavation, horizontal directional drilling, underground construction, shoring, and soil types as appropriate to the assigned task.
2. Have the ability to assure that all underground utilities are located, field verified, and clearly marked prior to excavation.
3. Be knowledgeable in applicable excavation regulations to include OSHA 29CFR1926. Have knowledge of trench collapse prevention, ventilation and air monitoring requirements (where applicable), ground water control, personal protective equipment, and emergency procedures as they pertain to underground construction and utility work. A minimum 5 years excavating experience is required.
4. Have the ability to notify the prime contractor or Government (as applicable) of any nonconformance issues and document them; and to provide any corrective actions to mitigate hazards or nonconformance issues.

In addition to the requirements specified in the previous list, the **EXCAVATION AND UTILITY COMPETENT PERSON** that is assigned to supervise **PERMIT PART B** activities shall:

5. Have the ability to review, understand, and interpret URDs, contract drawings, and specifications.
6. Have the ability to oversee and witness underground construction and utility work to ensure that established processes are followed. A minimum of 5 years utility installation experience is required.

7. Have working knowledge of hydro-testing and pigging, as well as welding and fusion procedures, as appropriate to the assigned task.
8. Be knowledgeable in applicable rules and regulations to include 29CFR1926 and installation of utilities such as domestic water (i.e. fire hydrants, thrust blocks, testing, cleaning and chlorination), sewers, duct banks, natural gas, and other pressure pipes, as appropriate to the assigned task.
9. Be capable of identifying existing and predictable hazards in the surroundings of underground utility construction and understanding the corrective measures to eliminate them.



# THE MARKINGS

## NASA GRC MARKING STANDARDS

The **American Public Works Association (APWA)** is the source for recommended color codes for utility marking at NASA GRC. Utilities are marked using colored flags and/or paint to identify the underground service.

- The contractor shall stake the alignment of new infrastructure based upon the design drawing layout and prior to requesting utility markings. The contractor shall also delineate proposed excavation limits based upon the design requirements using white paint.
- The NASA Utility Locator will identify and mark the horizontal alignment of all known underground utilities crossing or within the proposed excavation limits using the colors and symbology shown on the following pages. Areas of Concern, where an actual utility location may not fall within the Tolerance Zone (see page 24), will also be identified for further exploration.
- Excavation by hand digging, vacuum excavation, or hydro excavation, will be required at all utilities within the Tolerance Zone, including Areas of Concern.

## TABLE OF COLORS AND ABBREVIATIONS

### WHITE - By Contractor – Planned Excavation

**PINK** Temporary Survey Markings  
Area of Concern ( ! C ! )

**RED** Electric Power ( E )

**YELLOW** Natural Gas ( NG )  
Service Air ( SA )  
Steam ( ST )  
Combustion Air (CMBA)  
Fuel / Oil ( FO )  
Waste Gas ( WG )  
Carbon Dioxide ( Co2 )  
Liquid Fuel ( LF )  
Hi Press. Nitrogen (HPN2)

**ORANGE** Communications ( TEL )

**BLUE** Domestic Water ( DW )  
Cooling Tower Water ( CTW )  
Chilled Water ( CHW )  
Raw Water ( RW )  
Clarified Water ( CW )  
Hot Water ( HW )  
De-Ionized Water ( DIW )  
Fire Protection Water ( FPW )

**GREEN** Storm Sewer ( S )  
Sanitary Sewer ( SAN )  
Indust . Waste Sewer ( IWS )

## WHITE LINING-CONTRACTOR MARKINGS

Excavators at NASA GRC are REQUIRED to premark with white paint the limits of the intended excavation to clearly indicate for the Utility Locator and CM/Inspectors.



For single-point excavation such as borings for soil samples, for installing sign posts or fence posts, or planting a tree, mark the location with white paint using dashes.

For continuous excavation such as trenching, boring, and trenchless excavation, mark the center line of excavation with dashes in white paint. Excavation width (in feet) shall be indicated on either side of the center line in legible numbers.



For area excavations such as grading or scraping, mark the perimeter with dashes in white paint at intervals close enough to clearly establish the maximum limit of the disturbance.

White flags or stakes may be used in place of white paint. Markers used to identify the excavation area shall not be excessive or oversized.

## UTILITY MARKINGS–LOCATOR MARKINGS

### Markers Appropriate for the Area

Underground facilities and utilities will be marked using paint or flags in a combination appropriate for the area of proposed excavation. Marks will be placed at the beginning and end of the location area as needed to clearly identify the route of the underground utility.

**All markings** will be placed at the beginning and end of the location area and at a minimum interval of two feet but not more than fifty throughout the location area as needed to clearly identify the route of the underground utility.

**When flags are used** the identification abbreviation of the utility will be written on the flag using an indelible broad-tip marking pen.

**Abandoned utilities** remain in place at many locations within the GRC facilities. Any abandoned utilities within the location area will be marked similar to an active utility with the addition of letters “**ABAN**”.



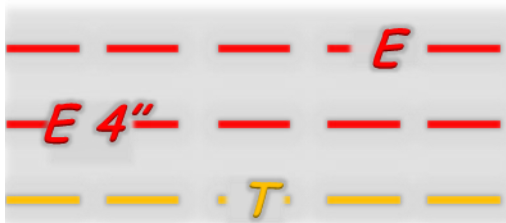


## MARKING BURIED CABLES

- A. Where a single cable or un-encased conduit is present the location will be marked by placement of a mark a minimum of 1 in. wide and 12 in. long spaced at intervals over the approximate center of the utility.



- B. If multiple cables or un-encased conduit are present they will be marked by placing a single mark over the approximate center of each line. If an individual un-encased conduit has a diameter greater than 2 in" the nominal size will be noted on the line.



## MARKING CONDUIT/DUCT BANK

The term "Duct Bank" is used for a structure containing one or more conduits and encased in concrete. Multiple runs of un-encased conduit will be identified as previously described in Marking Buried Cables (above).

- A. For all concrete encased Duct Banks 12 in. wide or less, the following information is provided: A single mark or line is used and the total width of the concrete encasement, in inches is given.



- B. For all concrete encased Duct Banks greater than 12 in. wide the boundary (width) is identified by parallel marks. A diamond is placed between the marks; and the number of ducts horizontal (H) x the number of ducts vertical (V) is indicated within the diamond symbol.



## MARKING PIPE LINES

Pipelines larger than 2 in. (nominal size): The physical location of a pipeline shall be represented by a single mark. The nominal size shall be noted.

— — *NG 8"* — —

## FOR ALL PIPELINES

- A. Pipelines that are inserted into casings will be marked to so indicate.

— — *NG 8"/12"C* — —

- B. Marks shall be placed at the beginning and the end of the location area and at intervals throughout as needed to clearly identify the pipeline location and width (diameter).
- C. All numbers identifying width shall be in inches.

## MARKING TERMINATION POINTS

Termination points, stub outs, and dead ends will be marked as shown.

**E** — — **DW 6"** — —

## MARKING CHANGES IN DIRECTION

Changes in direction of an underground utility will be marked to clearly define the route.



## OFFSET MARKS

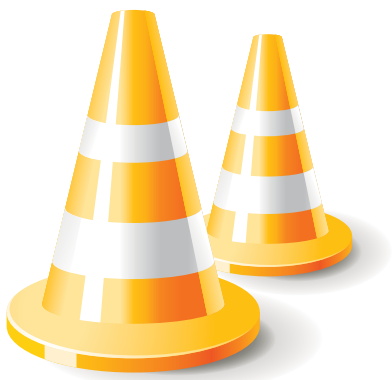
Where marks may be subject to frequent destruction, offset marks can be used to supplement the primary marks.



At a clear distance a line parallel to the utility is marked, including a perpendicular arrow and a distance in feet to the actual location of the utility. The arrow indicates direction to the utility. The utility abbreviation and size are shown on the other side of the arrow.

## VALVE PITS/MANHOLES/VAULTS AND STRUCTURES

The perimeter of valve boxes, manholes, vaults, and other buried obstructions will be marked with the appropriate color, abbreviation, and name or type. Natural gas blowoff pits and dual purge valve pits will include the location of the connecting line if known; otherwise, a caution zone will be established and marked.



## AREAS OF CONCERN

An “Area of Concern” exists when the location of a utility is not shown on record drawings, but the utility is presumed to exist based upon other evidence. These situations include, but are not limited to

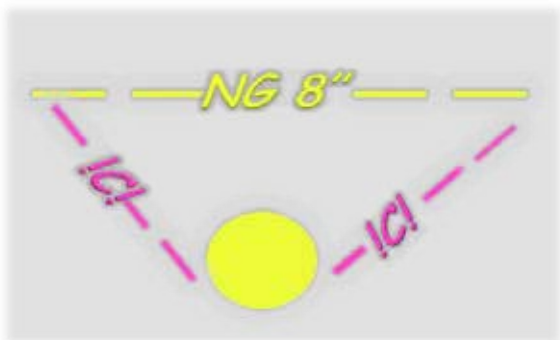
- An otherwise unidentified valve box, hand-hole, manhole, or other system appurtenance
- A natural gas blowoff or purge valve structure showing no connecting line on legacy record drawings
- A building foundation or pavement edge where an underdrain would normally be installed but is not shown (not normally delineated on legacy record drawings). Double parallel pavement underdrains each side of curb are common at Lewis Field
- Electrical ground grid at building footings (not normally delineated on legacy record drawings)
- Cathodic protection test box showing no connecting line on legacy record drawings

The contractor shall treat Areas of Concern as Tolerance Zones.



## AREAS OF CONCERN

An Area of Concern will be marked on the ground, showing the estimated maximum limits of a potential encounter. Horizontal limits of such areas may be based upon a radius around a fixture, a bounding box between a fixture and a known line, or parallel lines based upon the estimated horizontal maximum potential variation in a single line.



This example shows a natural gas line with an associated blowoff valve identified by its hand-hole lid (yellow circle). The location of the blowoff line is not shown on the record drawings. The Area of Concern for the blowoff line falls within the triangular area between the 8 in. NG line and the pit location indicated by the pink lines marked !C! The entire area will be hand excavated with caution until either the line is located or the Tolerance Zone limits are reached. Isolation valves for the 8 in. NG line should also be located and prepared for closure (keys in place) prior to potholing.

# EXCAVATION TOLERANCE ZONE

## ORC 3781.30 DUTIES OF EXCAVATOR

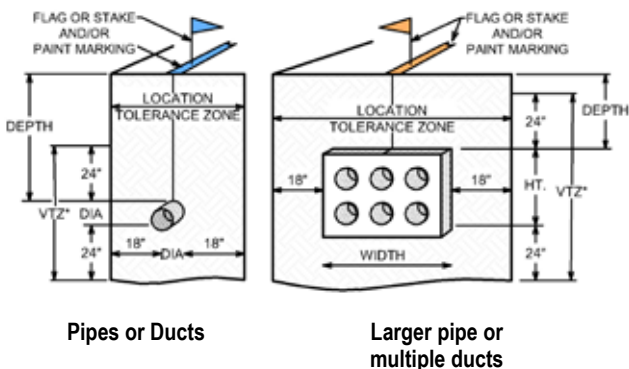
When making excavations using traditional or trenchless technologies, the excavator shall do all of the following:

1. Maintain reasonable clearance (defined as the “Tolerance Zone” on page 24) between any underground facility and the cutting edge or point of powered equipment.
2. Protect and preserve the markings of Tolerance Zones of underground utility facilities until those markings are no longer required for proper and safe excavations.
3. When approaching and excavating within the Tolerance Zone of underground utility facilities with powered equipment, require an individual other than the equipment operator, to visually monitor the excavation activity for any indication of the underground utility facility.
4. Conduct the excavation within the Tolerance Zone of underground utility facilities in a careful, prudent, and nondestructive manner, when necessary, in order to prevent damage.
5. Excavate up to the total depth of the excavation to either determine the precise location of underground utility facilities or verify that the total depth of excavation is free of such facilities.



## REMEMBER!

The "Tolerance Zone" is the total width of the underground utility plus 18 in. on each side. The "Vertical Tolerance Zone" (VTZ\*) extends from the elevation shown on the utility profile drawing 24 in. above the top edge and 24 in. below the bottom edge of the utility.



**Potholing** all utilities for verification is required prior to infrastructure excavation. Potholing is the process of safely excavating a hole in order to locate a utility that is known to be within the Tolerance Zone.

**Methods of excavation within the Tolerance Zone are:**

- Hand digging
- Vacuum excavation
- Hydro-Excavation

If a potholing waiver is granted by the Civil System Manager the contractor is **still** required to excavate in accordance within the Tolerance Zone using the methods listed above to expose the utility.

## UNDOCUMENTED CONDITIONS


You must notify your COR if an unexpected underground utility or structure is found during the activity, or notify Emergency Dispatch if a pressurized, electrical, or telecommunications underground utility or structure is hit or broken during the activity. (The requestor will notify the emergency dispatch at 911 if using a NASA internal telephone or if using a cell phone dial 216-433-8888 at Lewis Field or 419-621-3222 at Plum Brook Station.)



### EMERGENCY DISPATCH

911 (NASA Internal Phone)  
216-433-8888 (Lewis Field)  
419-621-3222 (Plum Brook)

# READING THE URDs



The network of underground utilities is extremely dense in many areas at GRC. Some of the utilities are unusual. Many contain hazardous materials or are physically dangerous.

Coming into unexpected contact with even an abandoned utility can have unpleasant results.

- Scaling a paper drawing should never be done for critical dimensions; even for estimating it is not good practice unless a graphic scale is shown for calibration.
- Elevations are always top of utility unless noted otherwise, such as inv. or f.l. (pipe invert or flow line).
- Most utilities are shown by centerline for horizontal location. A single line width can show the location of a single direct buried wire or a 30"-in.-diameter Combustion Air Line or a 48-in.-wide Power Duct Bank
- A 48-in.-wide duct bank that is perpendicular to a trench will have a crossing distance of 48 in. At a 45° angle to the trench the same duct bank will have a crossing distance of 68 in.
- The width of some duct banks are determined by the number and diameter of conduit as well as the estimated space between, and to the edges (3 in. normal); for example.

**5"CND-3Hx2V** on drawing calls out  
**5" dia. CoNDuit-3Horiz x(by) 2Vert.**  
 $H = 15"(\text{conduit}) + 12"(2 \text{ spaces} + 2 \times 3" \text{ cover})$   
 $H = 27"(\text{Width})$   
 $V = 10"(\text{conduit}) + 9"(1 \text{ space} + 2 \times 3" \text{ cover})$   
 $V = 19"(\text{Height})$

- Active utility centerlines are shown by a solid line type and labelled by system, material, size, and any appropriate known information.
- Abandoned utility centerlines are shown by a broken line type, fully labelled with the added notation "ABAN."

# URD ABBREVIATION TABLE

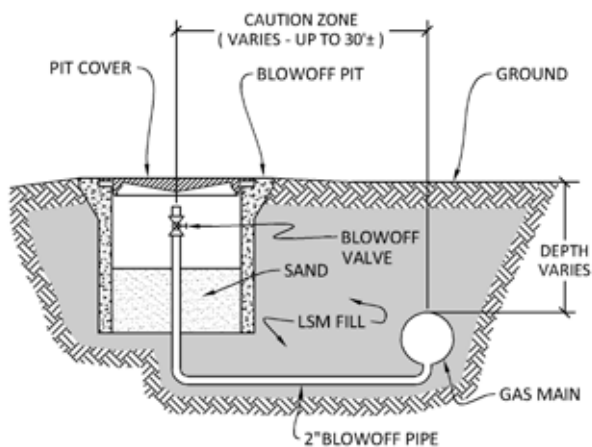
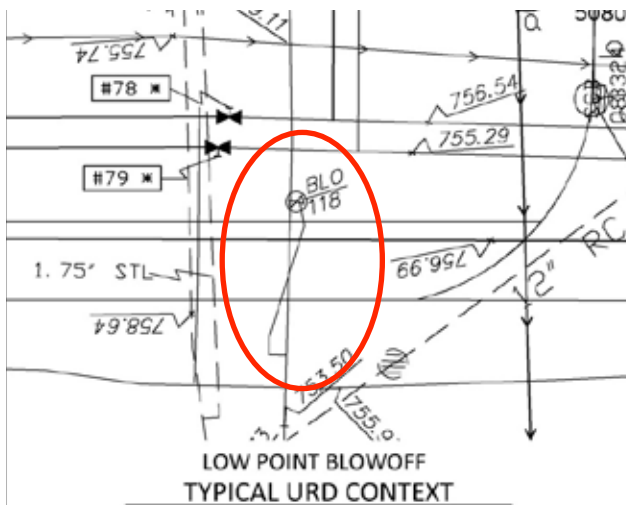
ABAN	ABANDONED	IWS	INDUSTRIAL WASTE SEWER
BC	BURIED CABLE	JB	JUNCTION BOX
BLDG	BUILDING	LF	LIQUID FUEL
BM	BENCH MARK	LPS	LOW PRESSURE STEAM
BOT	BOTTOM	LT	LIGHT
CB	CATCH BASIN	MH	MANHOLE
CHWR	CHILLED WATER RETURN	MON	MONUMENT
CHWS	CHILLED WATER SUPPLY	NG	NATURAL GAS
CI	CAST IRON	NIC	NOT IN CONTRACT
CICL	CAST IRON CEMENT LINED	P	POWER
CMP	CORRUGATED METAL PIPE	PB	PULL BOX
CND	CONDUIT	PC	POINT OF CURVATURE
CO	CLEAN OUT	PERF	PERFORATED
COMBA	COMBUSTION AIR	PI	POINT OF INTERSECTION
CONC	CONCRETE	PP	POLYPROPYLENE
CONN	CONNECTION	PT	POINT OF TANGENCY
COP	COPPER	PVC	POLYVINYL CHLORIDE
CPTB	CATHODIC PROTECT TEST BOX	RC	REINFORCED CONCRETE
CS	CARBON STEEL	R/W	RIGHT OF WAY
CTWR	COOLING TOWER WATER RETURN	S	STORM
CTWS	COOLING TOWER WATER SUPPLY	SA	SERVICE AIR
DG	DEGREES	SAN	SANITARY
DI	DUCTILE IRON	SCGR	STEAM COND GRAVITY RETURN
DP	DUAL PURGE	SCPR	STEAM COND PUMPED RETURN
DR	DRAIN	ST	STEAM
DS	DOWNSPOUT	STA	STATION
DW	DOMESTIC WATER	STL	STEEL
EL	ELEVATION	T	TELEPHONE
ENTR	ENTRANCE	TRAN	TRANSFORMER
E/P	EDGE OF PAVEMENT	UD	UNDERDRAIN
FD	FLOOR DRAIN	VAC	VACUUM
FDN	FOUNDATION	VB	VALVE BOX
FH	FIRE HYDRANT	VC	VITRIFIED CLAY
FL	FLOOR	VERT	VERTICAL
FO	FUEL OIL	VLV	VALVE
FOLQ	FOAM LIQUID	WM	WATER METER
FTG	FOOTING		
H	LETTER "H" IN HYDRANT		
HDPE	HIGH DENSITY POLYETHYLENE		
HH	HANDHOLE		
HORZ	HORIZONTAL		
HPS	HIGH PRESSURE STEAM		

# URD SYMBOL LEGEND

SYMBOL	DESCRIPTION
	ACTIVE UTILITY LINE
	ABANDONED UTILITY LINE
	GRAVITY LINE w/ FLOW DIRECTION
	DUAL PURGE VALVE (NATURAL GAS)
	BLOWOFF PIT (NATURAL GAS)
	TYPICAL VALVE
	PIPE REDUCER or INCREASER
	PIPE RISER or DROP
	STORM SEWER CURB CATCH BASIN
	STORM STRUCTURE w/ ROUND GRATE
	STORM STRUCTURE w/ SQUARE GRATE
	UTILITY MANHOLE w/ SOLID LID
	POWER POLE
	POWER POLE WITH STREET LIGHT
	STANDARD FIRE HYDRANT
	GRAVITY LINE CLEANOUT
	PIPE CAP OR PLUG
	EXTENT OF KNOWN LOCATION
	GROUNDWATER MONITOR WELL
	CATHODIC PROTECTION TEST BOX
	PUMP OUT FIXTURE
	HEAD WALL-CULVERT- END WALL

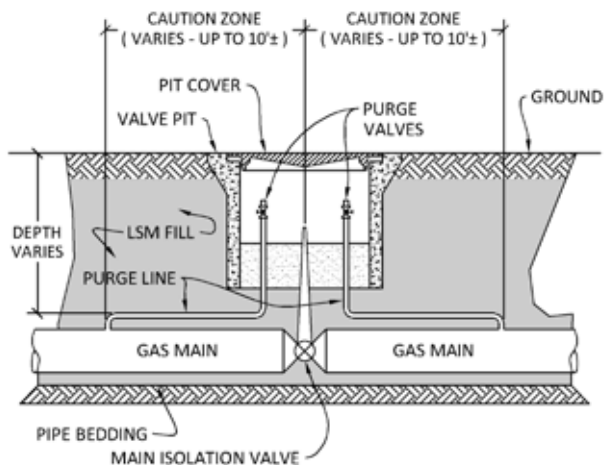
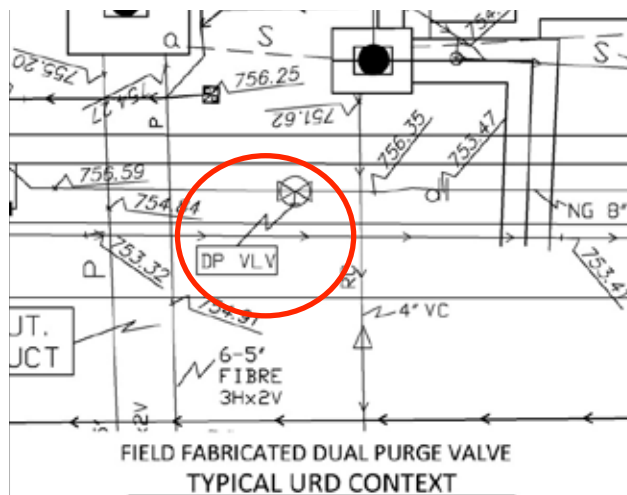
## TYPICAL CONSTRUCTION DETAIL

### NATURAL GAS LOW POINT BLOWOFF



## TYPICAL CONSTRUCTION DETAIL

### FIELD-FABRICATED DUAL PURGE VALVE



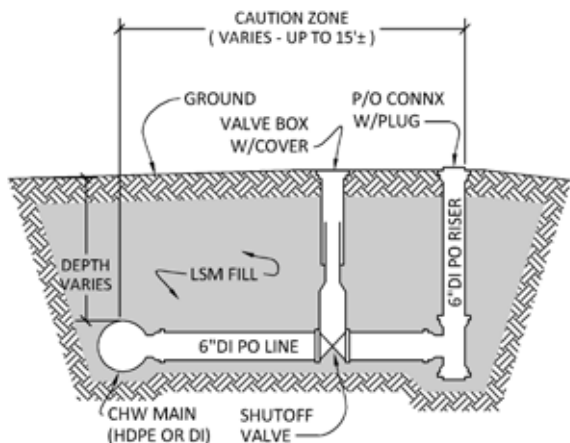


## TYPICAL CONSTRUCTION DETAIL

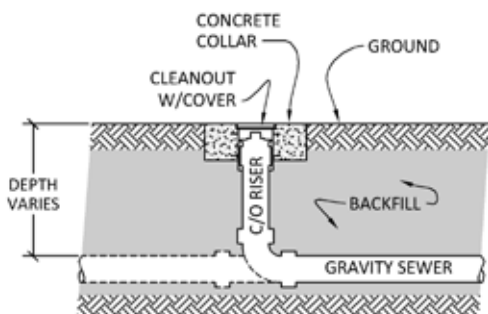
### WATER LINE PUMP OUT CONNECTION



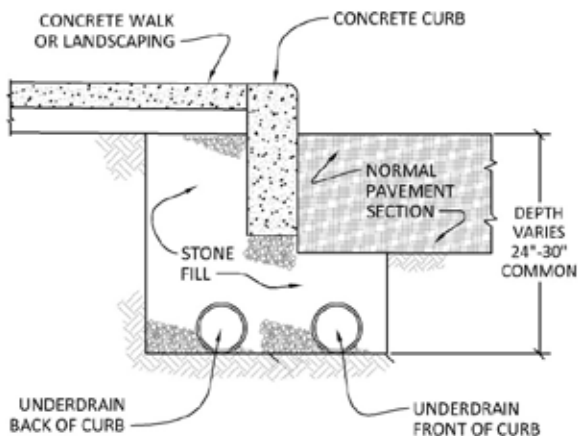
CHILLED WATER PUMPOUT CONNECTION  
TYPICAL URD CONTEXT



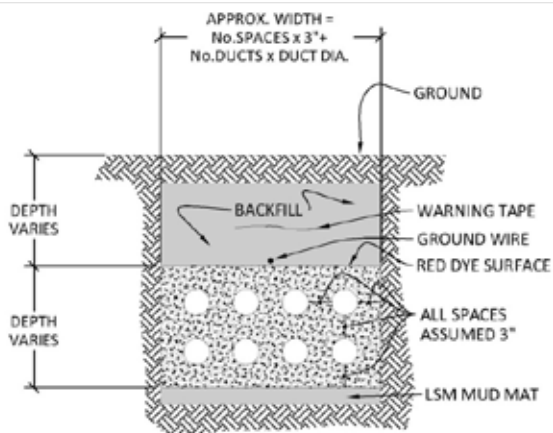
## TYPICAL CONSTRUCTION DETAIL GRAVITY SEWER CLEANOUT



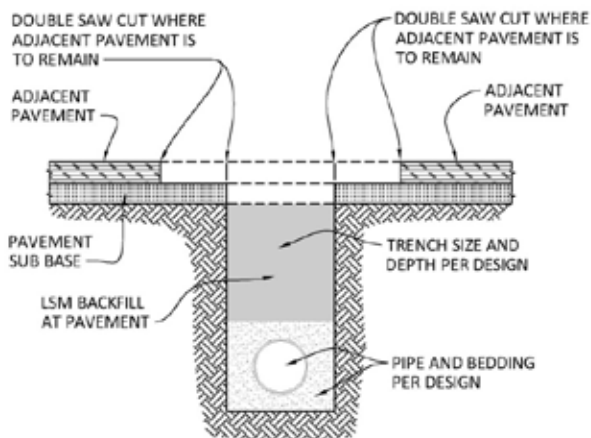
## TYPICAL CONSTRUCTION DETAIL DOUBLE PAVEMENT UNDERDRAINS



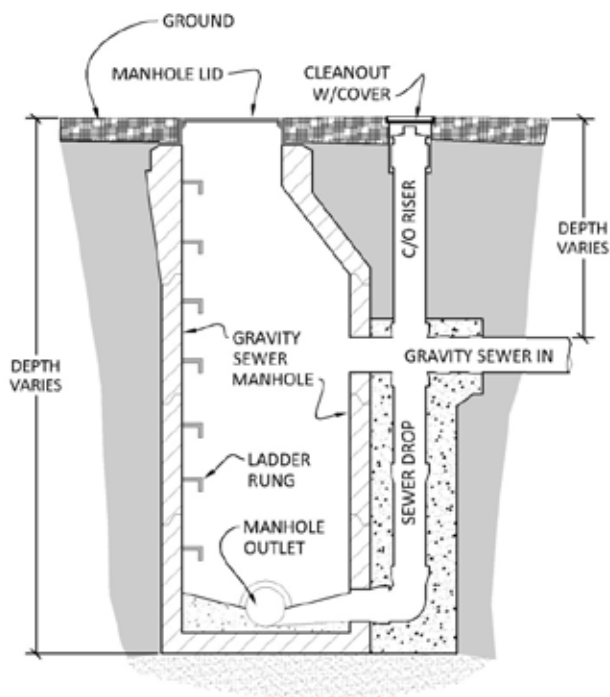
## TYPICAL CONSTRUCTION DETAIL CONCRETE ENCASED DUCT BANK



## TYPICAL CONSTRUCTION DETAIL PAVEMENT CUT/REPAIR AT PIPE TRENCH



## TYPICAL CONSTRUCTION DETAIL SEWER DROP MANHOLE WITH CLEANOUT



# EXCAVATION MANUAL



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## EMERGENCY DISPATCH

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216-433-8888 (Lewis Field)  
419-621-3222 (Plum Brook)

